

NOTES ON

- (a) RADIATION PATTERNS OF THE TRANSFORMATION OF
MAGNESIUM HYDROXIDE TO MAGNESIUM OXIDE.
- (b) SERPENTINE, MALACHITE, AND PSEUDOMORPH QUARTZ.
- (c) BULTFONTEIN APOPHYLLITE.
- (d) DIAMOND TESTS BY RADIATION PATTERNS.
- (e) DIFFRACTION FROM THE EDGES OF A SQUARE PLATE
OF IODINE.

By J. STEPH. v. D. LINGEN.

(With Plates I-VI.)

(a) RADIATION PATTERNS OF THE TRANSFORMATION OF MAGNESIUM
HYDROXIDE TO MAGNESIUM OXIDE.

In his lecture before the eighty-fifth Naturforscherversammlung in Vienna, Frederich described the appearance of certain Röntgen interference phenomena in the pattern of certain crystals.*

These phenomena consist of the usual pattern of points lying on conic sections, and in addition the phenomenon of radial lines emanating from these points towards the central point.

This latter phenomenon he ascribed to a two-dimensional grating effect of the crystal, co-existent with the usual three-dimensional grating.

Subsequently von Lane and the author contended that this phenomenon was not due principally to the space-lattice of the crystal, but rather to cleavage planes, which disturb the regularity of the three-dimensional grating.†

If the regularity is disturbed in one direction, only two of the three factors which determine the maximum intensity remain; hence the lattice of the crystal as a whole tends to become a two-dimensional one.

This latter contention is supported by the observations on the change of magnesium hydroxide to magnesium oxide.

On transmitting Röntgen rays parallel to the trigonal axis of a microscopically perfect piece of Brucite it showed the usual interference pattern of points without radial lines.

* 'Phys. Zeit.', 14, 1079, 1913.

† 'Nat. Wissenschaft,' 13, 319, 1914.

On heating the same crystal over 300 degrees, and obtaining its interference pattern at this temperature, the plate showed only six radial lines, with no trace whatsoever of the usual pattern.

The same specimen was then examined at room-temperature. In this case, *ceteribus paribus*, the plate showed an increase in the number of radial lines, but no interference points. That there are fewer radial lines in the former case than in the latter is due to the Debye effect.*

The intensity curve of the incident Röntgen rays is reflected in these radial lines, which now represent the complete reflected spectrum.

On examining the specimen macroscopically it was found to be now perfectly opaque, and so brittle that it crumbled into small flakes upon touching it.

The experiments recently carried out by the author show that the displacement of water molecules causes the displacement of the three principal points of the usual pattern, so that they become drawn out along radial lines, which seems to indicate a uniform displacement of the reflecting planes (*vide* Pl. I, Figs. 1 and 2 and Pl. II, Fig. 3).

Consequently we may conclude that whenever radial lines appear in the interference patterns there has been a weakening of the lattice of the original homogeneous crystal.

(b) SERPENTINE, MALACHITE, AND PSEUDOMORPH QUARTZ.

Serpentine.

Some crystallographers classify Serpentine as triclinic, whereas others simply state that the form of crystallisation is uncertain. Therefore it may be interesting to consider what light treatment with X rays may throw upon the matter. Moreover, it appears to be physically analogous with pseudoisotropic liquids when placed in a magnetic field.

It seems analogous only in so far as one axial direction is fixed.

A plate of Carolina (Transvaal) serpentine $\frac{1}{2}$ mm. thick was placed so that the threads were perpendicular to the incident rays. After an exposure of four hours the photographic plate showed a pattern symmetrical about the direction of the threads. The radial lines parallel to the threads showed a greater intensity than the subordinate lines, which are inclined at 30° and 60° respectively to the threads (*vide* Pl. II, Fig. 4).

On rotating this crystal round the direction of the threads through an angle of 60° , the subordinate lines were hardly discernible after an exposure of three hours.

If this mineral be heated the subordinate lines would probably vanish, and the pattern would consist only of a line parallel to the threads—phenomenon displayed by pseudoisotropic layers of para-azoxyanisol after an exposure of some forty hours.

* 'Phys. Zeit.' 15, 75, 1914; 'Nat. Wissenschaft,' 15, 371, 1914.

The pattern clearly indicates that the lattice of Serpentine has symmetry in a definite direction relative to the threads; hence it cannot be triclinic, which shows no symmetry whatsoever,* in interference patterns, except when it is uniformly twinned.

Malachite.

Secondly, a plate of Malachite, cut parallel to the slightly radiating fibres, was examined. After an exposure of three hours, the pattern showed three lines parallel to the threads and a number of secondary lines perpendicular to the principal line.

The two lines parallel to the principal line are faint in comparison with the principal line and the short secondary lines (*vide* Pl. III, Fig. 5).

Pseudomorph Quartz (Crocidolite).

A plate of Pseudomorph Quartz was examined, and the photogram, after an exposure of six hours, showed an intense dispersion round the central spot, accompanied by thin radial lines, making a small angle in the direction of the threads. This seems to indicate that this substance is microcrystalline and that the miniature crystals are so orientated that their normals to their reflecting planes favour the direction of the threads (*vide* Pl. III, Fig. 6).

Experiments on minerals of a similar nature are still in progress.

As far as these observations go, they seem to indicate that though the crystals show the characteristics of microcrystalline substances, nevertheless they also indicate that the elementary units still favour particular directions, and these directions give an index to the nature of the original lattice.

These radial lines indicate the loci of the principal points of the point-pattern of the original crystal, and also give an indication of the stability of the lattice.

Thus a new field of research is opened with regard to the transition stages in crystals. We wish to thank Prof. Young for supplying us with the specimens.

(c) BULTFONTEIN APOPHYLLITE.

In an earlier communication it was shown that a slight displacement of any cleavage planes within the crystal would cause an irregular distribution of the intensity in any individual spot to which that plane under ordinary conditions contributes its share of reflection, *i.e.* the intensity which it would have added to a definite part of the spot is now reflected to some other position, consequently irregularities caused by cleavage cracks will produce irregular spots.†

* Haga and Jaeger: 'Proc. Kon. Akad.,' Amsterdam, 15, 1552, 1916.

† 'Trans. Roy. Soc. South Africa,' vol. v, part 5, 571, 1916.

In order to test this, two specimens of Apophyllite were irradiated normally to their planes of cleavage. The first specimen showed a discontinuity along a plane of cleavage. This discontinuity did not extend throughout the crystal, and could only be detected microscopically after very careful examination. The second specimen, for which I am indebted to Prof. Shand, was perfect.

The interference pattern of the first showed a slight distortion of the points, which presented a nebular appearance (Pl. IV, Fig. 7), whereas the second specimen showed well-defined elliptic spots.

(d) DIAMOND TESTS BY RADIATION PATTERNS.

1. Macle.
2. "Spotted Stone."
3. Spotted Rejection Stone.
4. Inferior Brown Block with black spot in it.

1. *The Macle*,

which was examined some years ago, showed the usual pattern, together with a second one similar to the first, but rotated through 180° . This shows that the second lattice is similar to the first, but that it is rotated through two right angles. The spots in the pattern do not indicate any discontinuity in the lattice in the particular specimen (Pl. IV, Fig. 8).

2. "*Spotted Stone*."

This stone, apparently perfect but for a small black spot in the interior, showed after an exposure of three hours that some of the spots in the regular pattern were affected by the presence of the spot in the crystal. The slight discontinuity in some of the spots is only revealed when the photographic plate is placed at a considerable distance from the crystal.

The discontinuities in the various spots show that the disturbing influence is not the same for all the spots affected, but that the lattice of this stone as a whole remains perfect; that is to say, that there is neither a fracture in the lattice nor a rotation of its component parts (*vide* Pl. V, Fig. 9).

At this point we wish to express our indebtedness to the De Beers Consolidated Mines for the loan of this stone.

3. *Spotted Rejection Stone*.

This stone, bounded by a fairly smooth octahedral cleavage plane, was irradiated normally to it. After an exposure of three and a half hours the pattern showed that the lattice was ruptured, so much so that the usual elliptic spots were represented by irregular discontinuous markings, spaced at various intervals. The diamond as a whole seems to consist of units

more or less similarly orientated, each of which tends to produce its individual pattern.

The effect produced by these elements is augmented by rotating the crystal through a small angle, because the spots which recede from the centre become elongated, and hence show their component parts. In a perfect diamond the receding spot would be a uniformly drawn-out ellipse, whereas in the Rejection Stone it becomes a group of irregular spots (Pl. V, Fig. 10).

4. *Inferior Brown Block with black spot in it.*

This stone was also irradiated normally to an octahedral face. After an exposure of three hours the pattern showed that the crystal as a whole has less discontinuities in its lattice than the Rejection Stone. The pattern, however, shows that the distribution of the intensity in the spots is not uniform, and in addition there are several markings which are not caused by the regular lattice (Pl. VI, Fig. 11).

At this instance we wish to express our thanks to Dr. Percy A. Wagner for kindly lending us the above-mentioned stones.

(e) DIFFRACTION FROM THE EDGES OF A SQUARE PLATE OF IODINE.

A 4 mm. square plate of iodine was placed normal to the diaphragm in order to obtain its interference pattern. After an exposure of about one hour the experiment was discontinued, and the plate developed. This plate showed the unexpected phenomenon of diffraction from the edges of the crystal (Pl. VI, Fig. 12).

In some respects it is similar to the phenomenon described by Prof. Laub of Buenos Ayres.

These investigations were carried out by means of the grant in aid of Research, for which we wish to express our sincere thanks to the Government.

X-RAY ROOM,
SOUTH AFRICAN COLLEGE,
CAPE TOWN.